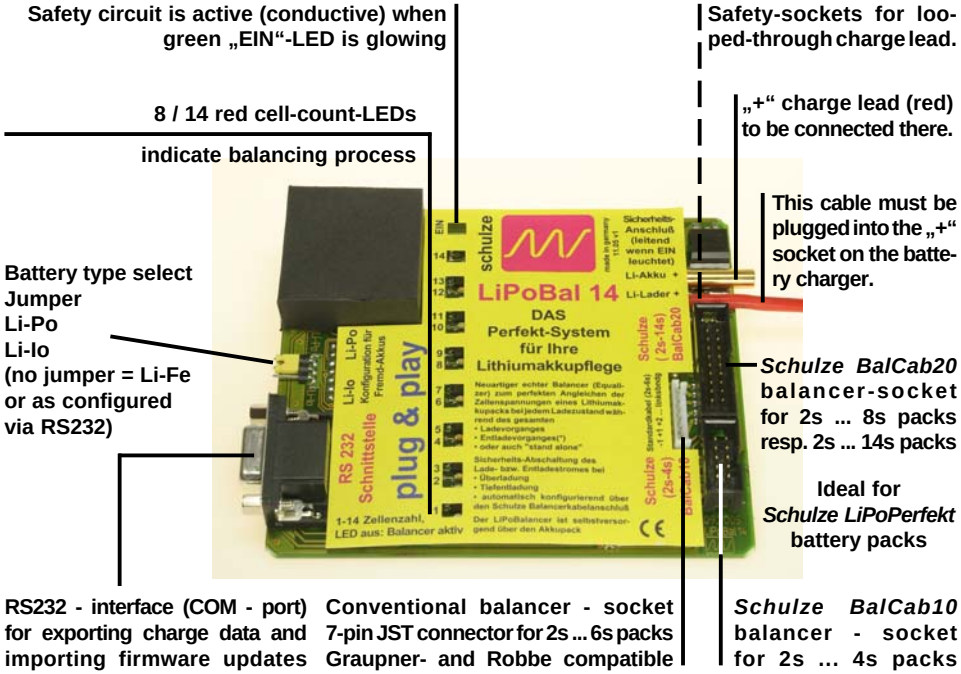
Safety circuit is active (conductive) when green „EIN“-LED is glowing
8 / 14 red cell-count-LEDs indicate balancing process
Battery type select Jumper Li-Po Li-Io (no jumper = Li-Fe or as configured via RS232)
RS232 - interface (COM - port) for exporting charge data and importing firmware updates
Conventional balancer - socket 7-pin JST connector for 2s ... 6s packs Graupner- and Robbe compatible
Safety-sockets for looped-through charge lead.
„+“ charge lead (red) to be connected there.
This cable must be plugged into the „+“ socket on the battery charger.
Schulze BalCab20 balancer-socket for 2s ... 8s packs resp. 2s ... 14s packs
Ideal for *Schulze LiPoPerfekt* battery packs
Schulze BalCab10 balancer - socket for 2s ... 4s packs
LiPoBal 14
DAS Perfekt-System für Ihre Lithiumakkupflege
plug & play
RS 232 Schnittstelle
Li-Io Li-Po Konfiguration für Fremd-Akkus
1-14 Zellenzahl, LED aus: Balancer aktiv
Sicherheits-Anschluß (leitend wenn EIN leuchtet)
Li-Akku +
Li-Lader +

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1 Introduction

Dear customer,

Congratulations on your choice of the Schulze ***LiPoBal***ancer, which is an outstanding device for monitoring and maintaining your valuable Lithium batteries.

The ***Schulze LiPoBal***ancer is primarily intended for matching (balancing, equalizing) the voltages of individual cells in a Lithium battery pack (Li-Fe, Li-Io, Li-Po) consisting of series-wired battery cells.

The purpose of the ***Schulze LiPoBal***ancer is to ensure that the cell voltages at the end of the charge process are virtually identical; this guarantees that the battery's maximum capacity is available subsequently for discharging. At the same time the process minimises the negative effects caused by slight variations in cell capacity in the pack as a whole, cell ageing, and minor damage caused by cell overloading, which can lead to loss of battery capacity and load capacity. The net result is that your batteries have the highest possible discharge voltage.

Although the ***Schulze LiPoBal***ancer is designed primarily for use with Lithium batteries, it can also be connected to Nickel batteries (Ni-Cd, Ni-MH) and used as a means of documenting discharge curves.

In this mode the ***Schulze LiPoBal***ancer does not balance cell voltages; it acts as a measuring system for selecting cells under high load current conditions.

The ***Schulze LiPoBal 08*** (2 … 8 cells) and ***Schulze LiPoBal 14*** (2 … 14 cells) are balancing devices which start adjusting the cell voltages to each other right from the first minute (at up to 1 Amp peak current). As such they really deserve the title of genuine balancers or equalizers, i.e. they balance cell voltages constantly when a battery is connected, instead of just limiting the cell voltage at the end of the charge process when the batteries are full.

Schulze LiPoBalancers exploit a completely new method of cell balancing - a method which is extremely efficient. It works virtually by transferring energy from cells with high voltage to cells with low voltage. No energy is wasted ("boiled away") - so the ***LiPoBal***ancer remains cool. The net result is this: cell voltages are balanced faster, the charger detects a full pack more quickly, and there is no danger of the balancer burning out.

An integral safety cut-off circuit works on the charge or discharge current, and protects the battery connected to the system if, for example, you set the charger incorrectly for that pack (e.g. if you select a NiCd charge program). For the safety cut-off circuit to work, all you have to do is loop it into the existing connections in your battery's charge lead.

Schulze balancer cable sets (***BalCab10-xxx*** and ***BalCab20-xx***) offer one very special feature: the safety circuit is configured automatically when the battery is connected using the ***Schulze***-specific cable sets, and the optimum method of working of the balancing circuit is also selected automatically - there is no scope for user-error. This is possible because these cables contain three more cores than usual, and the circuitry of the ***Schulze LiPoBal***ancer uses this additional information to detect the type of battery connected and the maximum permissible charge current for this battery type (the latter information is currently not used).

The make-up of these balancer cables, and the correct configuration of the three extra terminals, is described in the instructions for the ***BalCabXX sets***; the sets are designed to enable you to assemble your own connecting leads between the battery and the balancer quickly and easily.

The situation is even more straightforward if you use our ***Schulze LiPoPerfekt*** battery packs, which are fitted with a socket correctly configured to the battery. All you have to do with these packs is connect them to a ready-made balancer extension lead (***BalCab10-Verl*** or ***BalCab20-Verl***).

If you are using conventional balancer leads the ***LiPoBal***ancer must be configured manually using a jumper or via the PC connection (RS232 port).

Although the main purpose of the ***Schulze LiPoBal***ancer is to provide accurate, intelligent balancing of cell voltages in battery packs consisting of 2 … 8 or 2 … 14 cells, it can also be used for analysing and documenting the quality of your Nickel or Lithium battery packs thanks to its integral RS232 interface. This is best done by discharging them at fairly high currents; in this case the integral safety circuit can be used to cut off the process when the battery is fully discharged, operating at currents up to 15 A.

If the safety circuit is tripped, the charger may ramp up the converter voltage to 60 V; unlike other poorly designed, so-called "safety circuits", the ***Schulze LiPoBal***ancer will not be damaged if this should happen.

The ***Schulze LiPoBal***ancer requires no additional power supply; it draws voltage / current from the battery to which it is connected.

2 Warnings

- The CE symbol does not entitle you to handle the device without reasonable care.
- Never leave the device unsupervised during a charge process.
- When the system is operating, the device, the charger / discharger and the connected batteries must stand on a non-inflammable, heat-resistant and electrically non-conducting surface.
- Inflammable objects and volatile gases must be kept well clear of the device(s).
- Protect the unit from dust, dirt, damp, liquid, vibration, shock and pressure loads.
- Do not subject the device to excessively high or low temperatures.
- When a cell voltage balancing process is concluded, and - in particular - when a discharge process is finished with the ***Schulze LiPoBal***ancer connected, the battery must be disconnected from the **Schulze LiPoBal**ancer within a short time. This is especially important if the battery capacity is small and the cell-count low: with a 2s1p 350 mAh pack this means: within 10 minutes in LED cell-count display mode, and within 15 minutes in LED current-saving mode.

Reason: since the electronic circuitry of the ***Schulze LiPoBal***ancer is powered by the battery to which it is connected, the current drain of the balancer would completely flatten the battery if left connected. For the same reason you should also disconnect the speed controller from the drive battery after use.

The integral switching section of the ***Schulze LiPoBal***ancer places a much lower load on battery packs with high cell counts, which means that the residual energy in an almost discharged pack lasts longer in normal use.

There is a danger that the battery will be damaged if deep-discharged. To test this we carried out the following experiment, and actually detected no damage at all:

We left a flat 6s2p 4000-2 pack connected to the balancer overnight. It was then disconnected from the balancer and recharged using a very low current (1/20 C; 250 mA = the charger's lowest output rate) from around 3 V overall voltage. Under continuous observation we recharged the pack to slightly more than 3 V per cell using a Ni-Cd fixed current program (!), i.e. until the total pack voltage was around 19 V. At this point it was again connected to the balancer, and then recharged completely at 1 C (4 Amps) using the Li-Po program. Despite the deep-discharge, the battery was found to have the same capacity, and was capable of delivering the same currents under load.

3 Commonly used terms

Final charge voltage: the voltage at which the battery's charge limit (or capacity limit) is reached. When the ***Schulze LiPoCard*** is in use, the current is reduced to less than 8% of the configured value at this point. The charger then switches off, and displays the "battery full" indicator.

Final discharge voltage: the voltage at which the battery's discharge limit is reached. The chemical composition of the batteries determines the level of this voltage. Below this voltage the battery enters the deep discharge zone. Deep discharged cells can cause permanent damage

Power-On (- reset): the status of the ***Schulze LiPoBalancer*** after it has been connected to the car battery.

Ready display: the charger is ready (batteries disconnected) to operate at the currently selected configuration. When in this state the unit displays the set configuration by means of continuously glowing LEDs.

Charge Quantity, Capacity: see C and Ah resp. mAh.

C: Coulomb or capacity: Unit of measurement relating to the quantity of charged energy. In conjunction with charge current data this unit is used to determine the recommended / prescribed charge current of a battery of a given capacity. Example: if the charge current of a 1100 mAh battery is 2,2 A, we refer to this as a charge of 2 C.

A, mA: unit of measurement relating to charge or dis-charge current. 1000 mA = 1 A (A=Ampere, mA=Milliampere). Do not mix up with:

Ah, mAh: unit of measurement for the capacity of a battery (Amperes x time unit; h = hour). If a pack is charged for one hour at a current of 2 A, it has been fed 2 Ah of energy. It receives the same quantity of charge (2 Ah) if it is charged for 4 hours at 0.5 A, or 15 minutes (=1/4 h) at 8 A.

4 Useful information about batteries and maintenance

4.1.1 **Li-Io** (Lithium-Ion) cells are housed in a strong metal can, usually of cylindrical shape. Their designation is derived from the ion-conducting fluid electrolyte. The rigid metal container is required to ensure that the electrodes are pressed firmly enough against the separator. Li-Io cells of cylindrical and prismatic format have been in existence for many years; they were originally stated to have a nominal voltage of 3.6 V, with a maximum charge voltage of 4.1 V.
Some distribution companies now state a maximum charge voltage of 4.2 V for the Li-Io cells which have been developed more recently. In our opinion we should always rely upon the voltages stated by the cell manufacturer, i.e. the company which designed the cell.
As a basic rule the Li-Io cells stated to be safe at 4.2 V can also be charged to 4.1 V. If you do this, you can usually - depending on the cell design - expect a slight extension of useful battery life, combined with a reduction in usable capacity.

4.1.2 **Li-Po** (Lithium-Polymer) cells derive their designation from the polymer foil which was originally used as the electrolyte. This "solid" electrolyte was only capable of supplying current at temperatures of around 60ºC or higher; later the electrolyte was enriched with various supplement. materials to provide improved conductivity at lower temperatures.
The characteristics of these new cells made it possible to house them in a lightweight foil pack ("flat-pack"); these cells provide a high performance at room temp., although they still have slightly more to offer at 42 ºC.
The uniform nominal voltage of these cells is stated as 3.7 V, the maximum charge voltage as 4.2 V.

4.1.3 **Li-Fe** (Lithium-Iron-Phosphate „Saphion") cells have a voltage range, which makes this cell ideal for a replacement of a 5 cell Ni-Cd receiver battery. By means of its high current carrying capacity (up to 15 C) it is also suited for motor loads. A 3s Li-Fe pack replaces 8 nickel cells.

4.2 As differences between types is generally not made clear in the modelling world, we provide the following definitions:

4.2.1	**Nominal voltage**	**Li-Io:**	**3,6 V** / cell (SAFT)
		Li-Io/Li-Po:	**3,7 V** / cell (SANYO, KOKAM)
		Li-Fe:	**3,2 V** / cell (SAPHION)
4.2.2	**Max. charge voltage**	**Li-Io:**	**4,1 V** +-40mV / cell (SAFT)
		Li-Po:	**4,2 V** +-50mV / cell (MoliCel); absolute limit 4,3 V / cell
		Li-Fe:	**3,65 V** for longest life, up to 4,2 V / cell possible
4.2.3	**Min. discharge voltage**	**Li-Io:**	**2,5 V** / cell (MoliCel), **2,7V** / Zelle(SANYO)
		Li-Po:	**3,0 V** / cell (KOKAM) - absolute limit 2,3 V / cell
		Li-Fe:	**2,0 V** / cell (SAPHION)

4.3 **Selecting the fast charge current - if the manufacturer does not specify other values:**
Charge current = 1 C (SANYO / KOKAM) or less (0,7 C PANASONIC), (up to 2 C SAPHION).

4.4 **Maximum continous discharge current when used as a drive battery:**
Depending on the cell type: 1 ... 20 C continous current.

4.5 **Long time storage**: **Empty,** i.e. discharged to the discharge voltage cut off level (see maintenance), at low temperature (-20°C bis +10°C); Li-Fe (SAPHION)**:** Up to 6 months between 30 % ... 50 % full at 23°C.

4.6 **Maintenance:** Discharge up to 1 C down to the above listed discharge voltages (+ 10% allowed). Always store these cells in the discharged state. If stored fully charged over a longer period, the result can be a permanent reduction in capacity.
When stored at +40°C or more charge them additionally a little bit every two months.
Li-Fe (SAPHION): Discharge after 6 month and charge in 50% of the capacity.

4.7 Setting the cell count with the *LiPoBal*ancer

Since cell voltages can only be balanced using balancer cables (***BalCab***xx), there is no need to set or adjust the cell count; the ***Schulze LiPoBal***ancer automatically detects the cell count.

4.8 Selecting the battery type with the *LiPoBal*ancer

4.8.1 If you have fitted your battery pack with a correctly configured balancer cable (***BalCab***xx), the ***Schulze LiPoBal***ancer will automatically detect the battery type. The method of configuring the balancer cable correctly is described in the "Operating Instructions" supplied with the ***BalCabxx set***.

4.8.2 The battery type is also detected automatically if you use a ***Schulze LiPoPerfekt*** battery pack, and connect this to the ***Schulze LiPoBal***ancer using a ***BalCabxx-Verl*** extension lead.

4.8.3 You only need to configure the battery type "manually" if you use a conventional balancer connector. The balancer is fitted with a 3-pin socket with a bridging plug (jumper) for this purpose, or you can configure it from your PC (please read Chapter 9 for details of this).

5 Connections, using the Balancer for the first time

5.1 Looping in the build in safety circuit (maximum permissible charge / discharge current: 15 Amps)

Connect your charge lead to the battery pack.
Ensure that the charger is correctly configured (battery type, cell count, charge current).
Take the 4 mm banana plug attached to the negative charge cable (-, black) and plug it into the corresponding 4 mm socket on your battery charger.
Take the 4 mm banana plug attached to the positive charge cable (+, red) and plug it into the "Li battery +" socket on the ***Schulze LiPoBal***ancer.
Take the 4 mm banana plug on the "Li charger +" cable attached to the ***Schulze LiPoBal***ancer (+, red), and connect it to the corresponding 4 mm socket on your charger.
At this point there is no operating voltage to the ***Schulze LiPoBal***ancer, so the charger does not "notice" that there is a battery connected. The integrated safety circuit therefore cannot work yet.

5.2 Connecting a battery fitted with a Schulze ***BalCab10*** or ***BalCab20***.

The ***Schulze LiPoBal***ancer simply needs to be connected to the balancer cable attached to the battery pack. Two sockets are available, according to the cell count and the balancer cable type:

5.2.1 the 10-pin socket for Schulze BalCab 10 and 2 … 4 cell battery packs.
5.2.2 the 20-pin socket for Schulze BalCab 20 and 2 … 8 or 2 … 14 cell battery packs.

Provided that the balancer cable is correctly configured, connecting the LiPoBalancer in this way automatically optimises it, and the cell voltage balancing process will be carried out with the minimum possible superfluous adjustment work (i.e. minimal energy interchange between individual cells). The balancing process is energy-saving, and is therefore completed more quickly (Pros can change the working procedure of the automatic sliding cell equalization process by a "Set" command - see chapter 9).

The method of configuring the balancer cable correctly is described in the "Operating Instructions" provided with the BalCabxxx set.

Schulze LiPoPerfekt packs are designed specifically for connection to BalCabxx-Verl extension cables, and - naturally - are configured correctly by us.

When the balancer cable is connected, current is fed to the Schulze LiPoBalancer, and the system starts to work.

5.3 Connecting a battery fitted with a conventional balancer cable.

5.3.1 Before connecting such a cable, you must first configure the ***Schulze LiPoBal***ancer to suit the battery type, either using the jumper (see Chapter 4.8 for more details on this). This is necessary since the conventional balancer sockets attached to Lithium batteries, i.e. those used by Graupner and Robbe, contain no information at all about the battery type.

5.3.2 After (!) you have set the cell type correctly, and after you have checked with great care that the negative terminal of the pack (negative, cell 1) is located at the left outer pin of the balancer cable socket (voltage sensor cable), it is safe to connect the balancer cable to the 7-pin socket for conventional balancer cables; you must connect it flush with the left-hand side (!).

When the balancer cable is connected, current is fed to the ***Schulze LiPoBal***ancer, and the system starts to work.
Hints for pros: The working strategy of the cell equalization process can be changed by a "Set" command (chapter 9).

Note: If the jumper is not plugged in the cell type has to be configured via the RS232 port.
Please see Chapter 9 for more details.

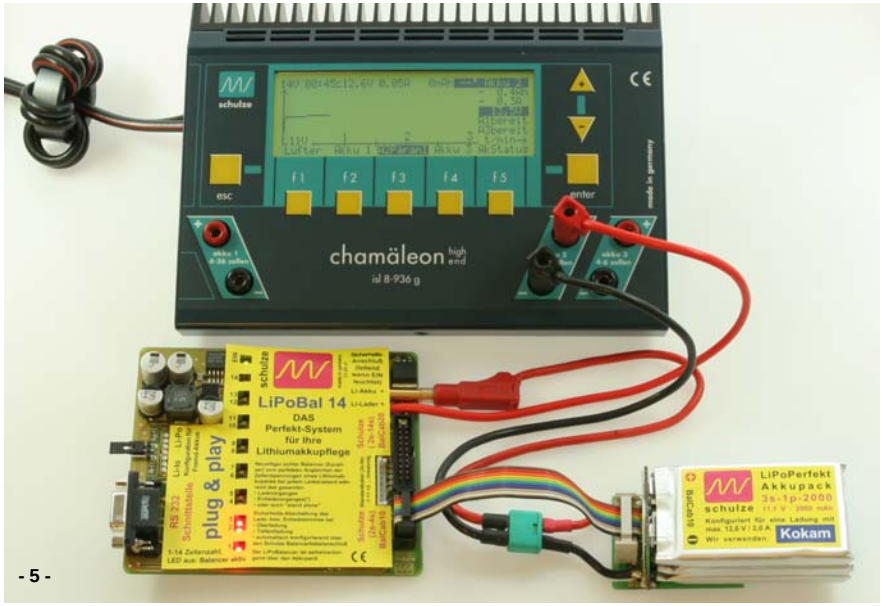
Note: the (red) connectors used by other manufacturers, e.g. Orbit, KD and Tanic, do not provide this battery type information either, but please note that their own balancer cables can and must not be connected directly to the ***Schulze LiPoBal***ancer, as they do not feature fixed connector assignment in the rising sequence of the cell count; this can be likened to the levels in a multi-storey building.

In antiquated systems which use limiter electronics (fallaciously sold as balancers), the limiter electronics connected individually to each cell generally have no idea of the voltage of the adjacent cell. This means that the circuit is completely incapable of balancing the cell voltages - it just acts on the one cell to which it is connected.

If you wish to use a ***Schulze LiPoBal***ancer to balance packs fitted with this type of connector, you should use the carefully designed concept of our ***BalCabxx set*** and solder the coloured wires directly in the pack in the appropriate sequence; alternatively solder them directly to the contacts of the individual cell tags outside the pack. In either case you must ensure that you maintain the correct sequence of the cells.

For this reason adaptor leads are not permissible, and must not be used.

When you have equipped your Lithium pack with the ***Schulze*** system, please turn to Chapter 5.2 for information on using the system for the first time.



The wiring to your charger should now look as shown in Fig. 5 above.

6 The LED operating indicators

The ***Schulze LiPoBal***ancer starts to work as soon as the balancer cable is connected, as it receives its operating voltage via the balancer cable.

Initially all the red LEDs on the ***Schulze LiPoBal***ancer will light up for about three seconds. There are eight or fourteen LEDs, depending on the variant you have purchased.

This is followed by a moving sequence of LEDs from cell 1 to cell 8, or from 1 to 14.

All the LEDs are then extinguished briefly, after which they come on again to indicate the connected cell count.

After about 15 seconds after connecting the battery the green "EIN" LED on the ***Schulze LiPoBal***ancer will light up.

The appearance of the green "EIN" LED also indicates that the safety circuit is armed. If you are using a ***Schulze*** charger (as shown above), the charger starts automatically; if you are using a different charger you may need to initiate the process by pressing the "Start" button.

After a further minute all the red LEDs go out - assuming that the LED display is working in current saving mode (LED indicator mode configuration for pros via "Set" commands: see Chapter 9).
At this point the balancer starts balancing the cell voltages - if necessary.

In LED current saving mode the LEDs only light up when a balancing process is in progress.

In LED cell count display mode the LEDs constantly indicate the connected cell count, and only go out when a balancing process is in progress.

If there are major voltage differences within the pack to be balanced, you will see one or more LEDs flashing continuously.

The set indicator mode is maintained until you disconnect the battery from the ***Schulze LiPoBal***ancer, regardless of any battery-full or battery-discharged message - unless the safety cut-off trips, and isolates the battery from the charger. The green "EIN" LED goes out (see also the LED error indicators: Chapter 8).

If one or more LEDs are even blinking after the „full" detection then you connected a pack with too much difference in the cell voltages and you charged it in that case with too much current. Let the pack remain for a short time on the ***LiPoBal***ancer to get a better equalization. After the balancing has finished resp. latest after the green „EIN" LED goes out you have to disconnect your pack to avoid deep discharging!

7 The safety circuit

7.1 The safety circuit consists of a bi-polar galvanically separated semi-conductor (solid state) relay circuit which can switch very high currents (up to 15 A).

It should always be looped into the charge lead (see Chapter 5.1) if your battery is to be balanced in conjunction with a charger or discharger.

The safety circuit isolates your valuable battery from the charger / discharger if the pack exceeds or falls below the battery-specific limit values, thereby preventing overcharging or deep-discharging at high current.

The battery-specific limit values are configured automatically when you connect the battery using a ***Schulze*** balancer cable.

If you are using a conventional balancer cable without battery type information, the battery-specific limit values must be configured manually. This is carried out using the 3-pin socket at the side of the balancer, which is fitted with a jumper as standard. The jumper should be fitted flush-left to configure the balancer for Li-Po, flush-right for Li-Io, and removed completely for Li-Fe. In any case this must be done before you connect the balancer cable.

Hint: The Li-Fe mode will be automatically switched to the Ni-XX (nickel battery) mode, when all connected cells have a voltage below 2,0 volts.

Important: even if you do not use the safety circuit, the versatility of the ***Schulze LiPoBal***ancer, i.e. its ability to work in conjunction with all battery types used in modelling, makes it absolutely essential to configure the battery type correctly, as the configuration also sets up the balancing process to match the characteristics of each battery type accurately; this avoids unnecessary shunting of energy to and fro during the balancing process.

An alternative method of setting the limit values and/or the strategy of the balancing procedure is to use the "**SET**" command via the PC interface (see also Chapter 9.4 - only for a pro).

7.2 Typical examples in practice

7.2.1 The charger charges a Li-Po battery with a Ni-Cd charge program selected.

The safety circuit cuts off the charge current in the looped-in charge cable at the precise moment when the maximum permissible cell voltage of at least one cell is exceeded.

(The battery is then almost full in any case, unless the cell concerned is actually defective, or has much lower capacity than the other cells in the pack.)

Once the safety circuit has cut off the charge current, the ***Schulze*** charger detects the "battery disconnected" state followed by "ready" or "GO". Foreign chargers may react different.

Wenn die Sicherheitseinrichtung den Ladestrom unterbrochen hat The green "EIN" LED on the ***Schulze LiPoBal***ancer goes out, and an error code is generated, i.e. the cell or cells whose voltage is excessive cause the associated red cell LED or LEDs to flash four times.

Disconnecting the balancing cable battery makes the ***Schulze LiPoBal***ancer ready for use again.

7.2.2 A You wish to discharge a Ni-Cd pack at high current using car headlight bulbs (Bilux bulbs) at up to 15 A *.

The voltage of the cells (max. 8 or max. 14 cells) is to be recorded and analysed on the PC in order to select the cells.

The ***Schulze LiPoBal***ancer does not need to be configured in any special way for this. If you remove the battery type configuration jumper, the balancer sets itself automatically to Nickel batteries, provided that all the connected balancer voltage tags indicate a cell voltage of less than 2 Volts (see above Chapter 7.1 **Hint**). The safety circuit will cut off the discharge current in the looped-in cable to the Bilux bulbs at the precise moment when the voltage of at least one cell falls below the minimum permissible value.

[*] If the safety circuit is wired across a high-current guard, for example, then it is also possible to analyse battery behaviour at higher currents. The current at which the battery is discharged makes no difference to the balancer inputs / outputs, as their only function is to measure the process. In Nickel battery mode the balancing function of the ***Schulze LiPoBal***ancer is switched off in any case.

8 The LED error indicators

When the green "EIN" LED is glowing, you can be sure that the balancer is operating normally. However, if the green LED is off, this indicates the presence of an error.

Since the LED indicator is coupled constantly to the safety circuit, an extinguished LED also means that no charge or discharge current is passing through the safety circuit.

If the balancer detects an error when you initially connect the battery using the balancer cable, then the green "ON" LED does NOT come on in the usual way after fifteen seconds.

When any of the following events occurs the balancer enters error mode:

8.1 Excess voltage error
Over-voltage of one or more cells (usually during the charge process). The LED(s) of the cell(s) with excess voltage flash continuously **four times** with a slightly longer interval.

8.2 Low voltage error
Under-voltage of one or more cells (usually during the discharge process). The LED(s) of the cell(s) with low voltage flash continuously **three times** with a slightly longer interval.

8.3 Wiring error

8.3.1 Missing cell(s): if there is a fault at the balancer connector in the wiring of the lowest cell(s), the LED(s) for the cell(s) flash continuously **twice** with a slightly longer interval; this indicates that one or more defective cells are at the bottom limit of operating voltage.

8.3.2 Missing cell(s): if a cell in the middle of a pack is accidentally (or intentionally) wired double - for example, if two balancer cables are assigned to one cell - a defective cell will also be detected, as described under 8.3.1, but with this difference: the LEDs will indicate an incorrect total cell count (one cell higher), and the incorrectly wired LED will not show up in the LED row. In this special case the Schulze ***LiPoBal***ancer works normally, as if there is no wiring error.

8.3.3 Skipped cell: if a cell in the middle of a pack is accidentally skipped, i.e. two balancer cables are assigned to one cell, then that cell will be detected with double voltage = over-voltage. This will trigger an error indicator exactly as described under 8.1, i.e. continuous **quadruple** flashing with a slightly longer interval.

8.3.4 Missed cell: if a cell in the middle of a pack is accidentally not connected, i.e. there is a dry solder joint in the balancer cable, then the LEDs will indicate both a defective cell, and also an over-voltage cell (the next cell).

The LED assigned to the cable with the dry solder joint shows a defective cell (as 8.3.1): the LED flashes **twice** continuously with a slightly longer interval.

The LED assigned to the next higher cell, even though connected correctly to the positive terminal of the balancer cable, shows an over-voltage cell (as 8.1): the LED then flashes **four times** continuously with a slightly longer interval.

8.3.5 Cells with wrong polarity / balancer leads soldered crossed (software version 4 and later): When a measuring input mesures a negative voltage then the correspondent LED flash continously **5 times** with a slightly longer interval. The pack has to be disconnected immediately to avoid a damage of the balancer or the balancing cable. If cell one is connected with wrong polarity the balancer sisplays for technical reasons a „missing cell" as shown in chapter 8.3.2.

Hint: All cell voltages are displayed on the RS232 serial interface (see chapter 9) so that you can analyze any problem the balancer shows on the LEDs.

9 The serial RS232 interface

9.1 General information

The ***Schulze LiPoBal***ancer generates status messages at the serial interface when the battery pack is connected: software version, cell count, balancer cable configuration etc. When the balancer is operating, i.e. during the balancing process, the interface supplies data which can be used to generate graphs of each cell's voltage curves on a PC, as well as the pack's total voltage; the data is compatible with ***Schulze winsoft***. The serial port can also be used to update the firmware of the ***Schulze LiPoBal***ancer. Serial transfer parameters: 9600 baud, no parity, 1 start-bit, 1 stop-bit, no flow control.

9.2 Connections

The port is optically coupled to (i.e. galvanically isolated from) the ***Schulze Li-PoBal***ancer, and is powered via the RS232 interface cable.

9.2.1 For example, the 9-pin socket of the RS232 port can be connected to a PC's RS232 port using an RS232 extension lead (***RS232-Verl***, 1 : 1, no crossed wires).

9.2.2 The 9-pin socket of the RS232 interface can be connected to the USB port of a PC or laptop using an ***RS232-USB-Adapt***or. If the USB adaptor is supplied with a USB extension lead, then you do not need an ***RS232-Verl*** extension lead. Note: to install the USB / RS232 driver please follow the instructions on the installation CD. Note also that the ***winsoft*** program can only address four COM ports. In some cases an IR port is assigned to COM2, and you may need to change the system settings (via device manager) to free up that port so that you can assign the USB adaptor to it.

9.3 Generating data graphs using *winsoft*

9.3.1 To obtain best results when generating graphs of individual cell voltages, run **winsoft** and select "4 x cell voltage" if the number of cells connected is up to four, or "7 x cell voltage" with up to seven cells. If the pack contains more than seven cells, the ***Schulze LiPoBal***ancer generates data for the eighth to the fourteenth cells as the voltage of the "battery 2" pack.
To depict the eighth to fourteenth individual voltages you have to use a little trick: open the "battery 2" window and then, when the serial data arrives, click the right mouse button, add "battery 2 online data", then select "7 x cell voltage".

9.4 For Pros: Configuring the *Schulze LiPoBal*ancer.

The ***Schulze LiPoBal***ancer understands a series of commands given via e.g. the HyperTerminal (included in the windows oerating system) which you can use to adjust the standard configuration to meet your personal requirements.
The first letter of a command ("S") must be entered within five seconds after the terminal program shows the version number of the balancer on its display as this switches the ***Schulze LiPoBal***ancer to configuration mode.
We have to differentiate between three groups of commands:

9.4.1 Commands which affect the LED indicators, the RS232 interface signal and the conclusion of the configuration process.

9.4.2 Commands which define the battery type; these are only effective if the balancer cable is not fitted with a configuration resistor (priority over the jumper), and if the jumper is fitted (priority over PC configuration).

9.4.3 Commands which set the limit values for the various battery types. If you enter an invalid SET command, the balancer responds with "illegal command". If you enter an invalid value, the response is "illegal value"; in this case the old value continues to apply.

The commands - may be written in capitals or lower case:

9.4.1.0 **Set** or **Set?** or **Set ?** (Software version 3 resp. 4 or later)
Displays all available „Set" commands.

9.4.1.1 **Exit** oder **SetExit**
Concludes configuration mode; no parameters required.

9.4.1.2 **SetDefault**
Sets all values to default settings, no parameters.

9.4.1.3 **SetShowBalancing** oder **SetLowPower**
Current-saving mode. The red cell count LEDs are off; they only glow during balancing.

9.4.1.4 **SetShowCells**
The red LEDs show the cell count; during balancing the corresponding LED goes out.

9.4.1.5 **SetD-BalancingOn** oder **SetDBalancingOn**
Balancer also active during discharging.

9.4.1.6 **SetD-BalancingOff** oder **SetD-BalancingOff**
Balancer inactive during discharging. (Hint: About 60 seconds after connecting the battery teh balancer detects „discharging" when the battery voltage drops (pack is not charging.)

9.4.1.7 **SetRS232CurrentOn**
In the interface data for ***winsoft*** shows the resistance value as a current value which is built into the ***Schulze BalCabxx set***, or which is built into the ***Schulze LiPoPerfekt*** battery pack.

9.4.1.8 **SetRS232CurrentOff**
Always shows no current in the Winsoft data, i.e. 0 (zero) is displayed.

9.4.2.1 **SetTypLiPo**
Sets the balancer to Li-Po mode if no configuration is present (***BalCab***).

9.4.2.2 **SetTypLiIo**
Sets the balancer to Li-Io mode if no configuration is present (***BalCab***).

9.4.2.3 **SetTypLiFe**
Sets the balancer to Li-Fe mode if no configuration is present (***BalCab***).

9.4.2.4 **SetTypNiXX**
Sets the balancer to Nickel mode if no configuration is present (***BalCab***).

	Command:		**min**	**max**	**default**	**unit**
9.4.3.1	**SetLiPoUmin nnnn**	nnnn = 2500	3300	2700	mV
	Sets the minimum voltage limit for Li-Po batteries					
9.4.3.2	**SetLiIoUmin nnnn**	nnnn = 2500	3000	2500	mV
	Sets the minimum voltage limit for Li-Ion batteries					
9.4.3.3	**SetLiFeUmin nnnn**	nnnn = 1800	2500	2000	mV
	Sets the minimum voltage limit for Li-Fe batteries					
9.4.3.4	**SetNiXXUmin nnnn**	nnnn = 600	1000	800	mV
	Sets the minimum voltage limit for Ni-Cd / Ni-MH batteries					
9.4.3.5	**SetLiPoUmax nnnn**	nnnn = 4200	4300	4300	mV
	Sets the maximum voltage limit for Li-Po batteries					
9.4.3.6	**SetLiIoUmax nnnn**	nnnn = 4100	4250	4200	mV
	Sets the maximum voltage limit for Li-Ion batteries					
9.4.3.7	**SetLiFeUmax nnnn**	nnnn = 3700	4200	4100	mV
	Sets the maximum voltage limit for Li-Fe batteries					
9.4.3.8	**SetNiXXUmax nnnn**	nnnn = 1800	2200	2200	mV
	Sets the maximum voltage limit for Ni-Cd / NiMH batteries					
9.4.3.9	**SetBalDiff nnnn** (Software version 4 or later)	nnnn = 5	200	auto	mV
	Sets the balancing precision to the typed value. To avoid a superfluous adjustment work we recommend to set this parameter to **auto** or **0** (zero=auto). This leads to a gliding funnel-shaped contracting of the allowed balancing deviation of about 200 mV at empty cells - down to about 5 mV at fully charged cells.					

10 Supplementary notes on using the *Schulze LiPoBal*ancers

10.1 In the NiXX battery type mode at least eight cells must be connected.

10.2 If the balancing process cannot be completed during the charge process due to over-voltage of one cell (caused by a severely unbalanced pack), the safety circuit trips and cuts off the charge circuit. The green LED goes out, and the charger "sees" a disconnected battery. If this should happen - especially if the pack has previously been problem-free in operation - it is important that you examine the battery to determine whether damage has occurred; for example: one of the cells in a parallel-wired pack may exhibit an internal or external break.

10.3 If you suffer an over-voltage safety shut-down (10.2), but a thorough inspection shows up no obvious problem, it is best to connect the pack to the Schulze LiPoBalancer again without the charger, and wait until the LiPoBal indicates no further balancing activity. As soon as possible after this it should be fully charged again before being re-used. Alternatively disconnect the pack from the Schulze LiPoBalancer so that the idle current does not discharge it to a dangerous level.

11 General tips on using Lithium batteries

- Read the instructions in the supplementary handling precautions carefully and observe them at all times.
- Do not disassemble, modify, heat or short-circuit the battery.
- Do not burn the battery or store it in a hot area.
- Do not drop the battery and/or apply excessive mechanical stress to it.
- Do not allow the battery to get wet.
- Do not use chargers other than those recommended by **Schulze**.
- Maintain the charging/discharging conditions specified in the handling precautions.
- During charging, use the safety feature(s) to protect the battery.

11.1 Charging instructions

- Lithium batteries must not be charged and / or operated in any combination with primary cells (dry cells) or other types of rechargeable battery (Nickel, Lead-acid batteries), or other types of Lithium cells (e.g. Li-Io with Li-Po), with cells of different capacity and / or make, and with cells of different maximum load capacity.
- Lithium batteries must not be charged using any charger or charge program which was intended for Nickel batteries (Ni-Cd or NiMH). These batteries must only be charged using a specialised unit such as the ***Schulze LiPoCard***, or a charger such as the ***Schulze isl 6*** or ***isl 8 series***; these devices include programs for charging Lithium batteries.

FIRE HAZARD! - if you do not observe the battery manufacturer's charging instructions, you risk damaging and even ruining the batteries (swelling, explosion); this can result in fire.

In particular please remember that the number of cells in the pack must be set correctly on the charger; note: this applies only to the number of cells wired in series. Parallel-wired cells are "seen" by the charger simply as one (1) cell "of large capacity".

- Before charging the cells it is essential to check the cell count setting and the maximum charge voltage on the charger.
- Before charging the cells it is essential to check the maximum charge current setting.
- Keep the battery well away from inflammable materials and volatile gases.
- During any charge / discharge process the balancer, the charger / discharger and the connected batteries must be placed on a non-inflammable, heat-resistant and electrically non-conductive surface. Such surfaces include ceramic dishes and flower pots, and special fireproof plastic or aluminium cases (these must be insulated, e.g. using plaster sheets).
- Don't charge batteries in the car - the seats burn very well …
- Supervise the charge process constantly - if the battery swells up, disconnect it from the charger immediately.
- Burning batteries should be extinguished with dry sand or a powder fire extinguisher - never with water - explosion hazard!
- Never attempt to recharge dead or damaged cells - this can have particularly disastrous results if these cells are part of a pack which also includes "healthy" cells.
- Protect the cells from mechanical loads!

11.2 Useful life

- Observe the charge current and discharge current limits stated by the battery manufacturer. Do not exceed the maximum values, as this brings a risk of drastic reduction in the pack's useful life.
- Contrary to much published information, the professional protective circuit for Kokam cells defines the lower and upper limits as 1.0 and 4.5 Volts per cell (http://www.kokam.com/english/biz/care.html).
- The most common cause of unbalanced battery packs is not "deep-discharging" to below 3 V / cell, but overloading through excessive discharge currents!
- Be cautious with dealers' statements such as maximum load currents of "15C" or "20C"; often this refers to peak load values, and not continuous currents.
- Lithium cells lose a small amount of capacity every time they are charged, but the loss is much higher if they are overloaded.
- Make sure your batteries are protected from short-circuit at all times! Whether the "short" is caused by a screwdriver in your toolbox or by a house-key in your trouser pocket, the result is the same: overloaded cells, and possibly a fire.
- If you deep-discharge a battery at a high current to a point below 1 V / cell, the result is invariably irreparable damage. In any application where high motor currents are used, the discharge limit for packs of identical cells must be in the range 2.4 … 3.0 V / cell. If the pack includes cells in different conditions, the discharge limit should be set even higher, to avoid the danger that the weakest cell might fall below the critical 1 V point when being discharged.

Our own experience shows that deep-discharges are not so critical if they are caused by the idle currents of electronic circuits (speed controller not disconnected from the flight battery after the flight, balancer powered by the battery and not removed after discharging the pack). However, if you discover a battery in this condition, charge it initially using a very low current (1/20C or less) until it reaches a voltage within the "working window" of the cells (for Li-Po cells that is 3.0 … 4.2 Volts).

- Since we are not in a position to ensure the proper use of the cells, the user is deemed to have accepted the responsibility once he opens the sales package. Thereafter he has no claim against the manufacturer, the importer, the dealer or the employees of those companies if an accident occurs in which personal injury or property damage result.

11.3 Cell handling

- The voltage of brand-new cells and discharged cells is not zero; it is generally more than 3 Volts. Short-circuit hazard!
- Never place cells or batteries on a conductive surface. Note that carbon fibre fuselages and carbon fibre spars are conductive!
- Do not place batteries in a micro-wave oven!
- Schulze LiPoPerfekt battery packs are protected at many points against accidental short-circuit, using cover plates, silicone, fabric tape and heat-shrink sleeving. Take care to avoid short-circuits at any unprotected points, and keep an eye open for abraded areas of the heat-shrink sleeving; if you discover a weak point, insulate it thoroughly.
- Keep individual cells and battery packs well away from youngsters, and store them out of the reach of children at all times. Many cells look rather like chewing gum or chocolate bars, and this is potentially confusing and dangerous.
- Do not open cells. The internal chemicals react with oxygen in the air and / or water, and in some circumstances the reaction can be violent. If a cell should catch fire and you have no suitable extinguishing agent to hand (sand, extinguisher powder), allow it to burn out, taking care not to breathe in the vapours generated by the fire.
- If the chemicals make contact with your eyes, immediately wash it off using plenty of water, and seek the assistance of a specialist doctor.
- The manufacturer's stated maximum discharge rates may be greatly exceeded when the cells are in use (typical of RC usage), which means that the cells are working under experimental conditions. As a result the manufacturer, the importer and the dealer are not liable for any claim under guarantee in respect of capacity, useful life, storage and discharge characteristics.

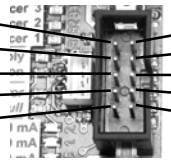
11.4 Disposal

- Discharge the cells slowly, ideally using a 1 … 10 kOhm resistor, which you can leave attached to the empty cells.
- Take the dead, discharged cells to your local battery collection point; packs purchased from us can also be returned to us.

12.1 Pin assignment of the 10-pin balancing cable of the *Schulze BalCab10-Set* resp. of the ***BalCab10-Verl*** for the ***Schulze LiPoPerfekt*** battery packs up to 4 cells.

Pin assignment *BalCab10* e.g. on the balancer plug of the ***LiPoCard***

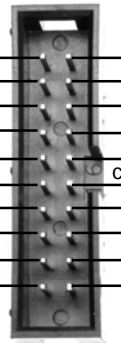
Cable colour	Assignment	Pin		Pin	Assignment	Cable colour
brown	battery +	10		9	'+' batt. ('+' last cell: 1,2,3 or 4)	red
orange	cell type	8		7	'+' cell 3 (no connect at 2s pack)	yellow
green	charge curr.(2)	6		5	'+' cell 2 (no connect at 1s pack)	blue
lilac	charge curr.(1)	4		3	'+' cell 1	grey
white	battery -	2		1	'-' cell 1 (battery -)	black



Hint:
A detailled description of the pinout and the mounting instructions are in the balancer cable kits.

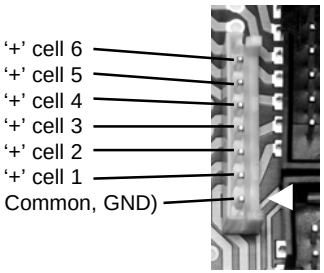
12.2 Pin assignment of the 20-pin balancing cable of the *Schulze BalCab20-Set* resp. of the ***BalCab20-Verl*** for the ***Schulze LiPoPerfekt*** battery packs up to 14 cells.

Cable colour	Assignment	Pin		Pin	Assignment	Cable colour
brown	battery - (-cell1)	20		19	battery +	red
orange	cell type	18		17	charge curr.(1)	yellow
green	charge curr.(2)	16		15	'+' 14 resp. batt.+	blue
lilac	'+' cell 13	14		13	'+' cell 12	grey
white	'+' cell 11	12		11	'+' cell 10	black
brown	'+' cell 9	10		9	'+' cell 8	red
orange	'+' cell 7	8		7	'+' cell 6	yellow
green	'+' cell 5	6		5	'+' cell 4	blue
lilac	'+' cell 3	4		3	'+' cell 2	grey
white	'+' cell 1	2		1	'-' cell 1 (battery -)	black



Hint:
A detailled description of the pinout and the mounting instructions are in the balancer cable kits.

12.3 Pin assignment of the 7-pin standard balancing cable (with JST-socket) for up to 6 cells.



13 Accessories

13.1 *Schulze BalCab10-Set*
Balancer cable kit for fitting to existing battery packs.
10-pin, for two to four cells in series.

13.2 *BalCab20-Set*
Balancer cable kit for fitting to existing battery packs.
20-pin, for two to fourteen cells in series.

13.3 *Schulze BalCab10-Verl*
Ready-made balancer cable for connecting ***Schulze LiPoPerfekt*** battery packs.
10-pin, for two to four cells in series.

13.4 *BalCab20-Verl*
Ready-made balancer cable for connecting ***Schulze LiPoPerfekt*** battery packs.
20-pin, for two to fourteen cells in series.

13.5 *RS232-Verl*
Cable for connecting the ***Schulze LiPoBal-***ancer to the RS232 port of a PC or laptop.

13.6 *RS232-USB-Adapt*
Cable for connecting the ***Schulze LiPoBal***anc-er to the USB port of a PC or laptop.

13.7 *Schulze LiPoPerfekt* Akkupack
3s1p 3200 pack with pre-configured 10-pin socket for the ***Schulze BalCab10-Verl*** extension cable.

Two examples from the extensive ***Schulze LiPoPerfekt*** battery pack range

13.8 *Schulze LiPoPerfekt* Akkupack
3s2p 4000 pack with pre-configured 20-pin socket for the ***Schulze BalCab20-Verl*** extension cable.

11 Legal matters

11.1 Warranty

All ***Schulze LiPoBal***ancers are carefully checked and tested before dispatch.

If you have a complaint, send the unit back to us with a clear description of the fault.

A message such as "doesn't work properly" or "software error" doesn't help us much!

Before you send your ***Schulze LiPoBal***ancer back to us, please test the unit **carefully,** as it costs us money to test a charger, and if it turns out to be in working order we have to recover those costs from you. In this case it makes no difference whether the **fully functional charger** is returned within the warranty period or not. Approved warranty claims are processed in accordance with our currently valid General Conditions of Business, which are printed in our catalogue resp. on our homepage.

One further note: if a problem arises with any ***Schulze*** product, send it directly to us without interfering with it in any way.

This ensures that we can repair the unit quickly, pick up warranty faults without any dispute, and keep costs to a minimum.

You can also be sure that we will fit genuine replacement parts which will work properly in your unit. Unfortunately we have had bad experience with third-party Service Centres which claim technical competence. Note also that any out-side interference with our products invalidates the warranty (e.g. the original pole clamps omitted or replaced). Incompetent attempts at repair can cause further damage. We often find it impossible to estimate the repair cost of devices in such condition, and in certain circumstances we are then obliged to decline to repair it altogether.

11.2 Limited liability / compensation

We at Schulze Elektronik GmbH are unable to monitor the observance of our assembly and operation instructions, our prescribed conditions and methods for installation, connection, usage and maintenance of our battery chargers. For this reason we cannot accept liability for loss, damage or costs which arise through the inappropriate use of our products, or are connected in any way with such use.

Within the normal legal limits, our obligation to provide compensation, for whatever legal reason, is limited to the invoice value of that quan-tity of product immediately involved in the event which caused the damage. This does not apply if we are obliged to accept unlimited liability in accordance with mandatory law due to our deliberate or serious negligence.

11.3 CE approval

All ***Schulze LiPoBal***ancer units satisfy all relevant and mandatory EC directives: these are the EMF directives

- 89/336/EWG, 91/263/EWG und 92/31/EWG.

The product meets the following basic technical standards:

Interference radiation: EN 50 081-1:1992, Interference susceptibility: EN 50 082-1:1992 and/or EN 50 082-2:1995.

You are the owner of a product whose design and construction fulfil the safety aims of the EC for the safe operation of devices.

The procedure also includes a test of interfer-ence susceptibility, i.e. the extent to which the charger is vulnerable to interference from other devices. The test involves subjecting the charger to RF signals similar to those produced by an RC transmitter or a radio telephone.

15 Specifications

Cell count range ***LiPoBal 08***	2 - 8	Li-Poly, Li-Ion, Li-Iron (Li-Fe)
Cell count range ***LiPoBal 14***	2 - 14	Li-Poly, Li-Ion, Li-Iron (Li-Fe)
Cell count with nickel-batteries	8 resp. 8 - 14	Ni-Cd, Ni-MH
Power supply voltage range	6 - 58.8	V DC (see cell count range)
Min. power consumption	10	mA @ 14 Li-Po cells
Max. power consumption	40	mA @ 2 Li-Po cells
rote LED min. Stromaufnahme	1	mA @ 14 Li-Po cells
rote LED max.Stromaufnahme	5	mA @ 2 Li-Po cells
grüne LED+Halbleiterrelais(min.)	2,5	mA (safety circuit conductive, 14 Li-Po's)
grüne LED+Halbleiterrelais(max.)	12	mA (safety circuit conductive, 2 Li-Po's)
Balancer socket 1	7-pin JST	no current and battery type coding
Balancer socket 2	10-pin Schulze	with current and battery type coding
Balancer socket 3	20-pin Schulze	with current and battery type coding
Battery type setting	automatically	when ***Schulze*** balancer cables are used
	manually	via jumper and/or serial interface
Balancing current up to	1	Amps peak (charge !) current
Max. total balancing power	12-14	W, depending on input- and pack-voltage
Balancing precision typical	5-10	mV (@ fully charged & „auto"-difference)
Dimensions approx.	120*102*17	mm
Weight approx.	145	g
Operational mode display ***LiPoBal 08***	via 8 + 1 LEDs	
Operational mode display ***LiPoBal 14***	via 14 + 1 LEDs	
Safety cut off equipment	bipolar DC-insulated solid state relay, maximum permissible voltage up to 75 volts; current up to 15 amps.	
Connectors for the safety equipment	4 mm gold plated socket, 4 mm safety plug on about 25 cm (10") cable.	
Data Interface	Serial RS232 opto coupled (DC-insulated) for status reports, cell voltage display, balancing data reports and firmware upgrades.	
Miscellaneous	Heat-shrink sleeve "case".	